# HOST AND GENERIC RELATIONS OF THE EUPHORINI (HYMENOPTERA: BRACONIDAE)

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## Abstract

The tribe Euphorini as presently constituted has 2 major groups of genera, the parasites of nymphal Heteroptera and Psocoptera and the parasites of adult insects. The tribe is here restricted to those genera parasitic on nymphal hosts and a new tribe, Perilitini (type genus *Perilitus* Nees 1818) is proposed for the parasites of adult insects. Keys are given to the Nearctic genera of each tribe. The relationship of structural modifications of the ovipositor and petiole with host specificity and method of egg deposition is discussed. The genera of both tribes have simple life cycles closely integrated with their hosts and synchronized with the seasonal occurrence of the life stage attacked.

The Nearctic Euphorini as presently constituted (Marsh *in* Krombein *et al* 1979) comprise 15 morphologically heterogeneous, small genera with the greatest number of species in *Microctonus* Wesmael and *Peristenus* Foerster. The group attacks a wide range of hosts in adult insects, and nymphs of various Heteroptera and Psocoptera. In this paper, the generic and host relations are discussed and a new tribe is proposed for the parasites of adult insects. Since Muesebeck (1936) revised the subfamily Euphorinae, Mason (1964) reported *Chrysopophthorus* Goidanich, and Shenefelt (1960), *Ropalophorus* Haliday for the Nearctic region. The Nearctic genus *Holdawayella* Loan, and the Holarctic *Townesilitus* Haeselbarth and Loan were described (Loan 1967, Haeselbarth and Loan 1983). The name *Ropalophorus* Haliday was validated for *Eustalocerus* Foerster (Hincks 1943), *Leiophron* Nees for *Euphorus* Nees (Muesebeck 1958) and for *Euphoriana* Gahan (Loan 1974), and *Peristenus* Foerster for a group of species removed from *Leiophron* (Loan and Bilewicz-Pawinska 1973).

The parasites of Heteroptera and Psocoptera show considerable diversity in certain structural features; however, the genera they represent appear to form a natural group. This is indicated by Muesebeck (1936) who noted that the ovipositor of nymphal parasites (*Euphorus*, *Euphoriana*, *Aridelus*) was subexserted but that it was prominently exserted in parasites of Coleoptera. The structure of the ovipositor, and possibly also of the petiole, indicates the method of egg deposition: if subexserted and strongly decurved, the host is grasped and held for oviposition, and if exserted, whether in the Euphorini or Perilitini, the host is parasitized by the parasite striking at it from various positions without grasping it. *Peristenus* and *Leiophron*, characterized by a subexserted, strongly decurved ovipositor and a short petiole chase the host nymph, and grasp and lift it from the substrate and insert the egg into the ventral area of the abdomen (Brindley 1936, Glen 1972). In this example, both the conformation of the ovipositor and of the petiole fit the requirements for oviposition in a small, active host. Little is known of *Aridelus*, but the unusually long and slender petiole may have developed to permit the gaster to reach around and under the dorsoventrally compressed abdomen of the nymph for oviposition. The exserted apical part of the ovipositors of the other parasites of Heteroptera is very short, and straight, and I have seen both *Holdawayella* and *Wesmaelia* strike repeatedly at a host nymph, often without success as no parasite eggs were recovered from the host. The tingid host of *Holdawayella* is gregarious and sedentary requiring little movement by the parasite to locate and parasitize it. The host is also spinose, and to oviposit the female parasite, in a lethargic manner, partly mounts the nymph and bends the gaster under its thorax or abdomen. On the other hand, the *Nabis* host of *Wesmaelia* is active and searches for prey, and it is parasitized by the parasite facing and striking at the side of the nymphs's abdomen, a method similar to that of *Microctonus*. The long petiole of *Wesmaelia* may allow it to oviposit at a maximum distance from its predaceous host.

Euphorines with prominent ovipositors attack adult hosts and form a second natural group of genera: 6 of the 9 genera are parasites of Coleoptera. These 6 genera are less diverse than the parasites of nymphs though the flagellum of *Ropalophorus* and *Streblocera* is highly specialized and the wing veins of *Cryptoxilos* are greatly reduced. *Microctonus* is the best known genus and it is clearly closely allied with *Perilitus* in structure and biology. The oviposition behavior of *Microctonus* has the parasite facing the host with the gaster bent downwards and forwards between its legs and the ovipositor extruded past its face; the ovipositor is then thrust into a specific area of the host's body. The ovipositor of *Microctonus* is straight or weakly decurved whereas that of the closely allied genus *Townesilitus* is distinctly decurved, which is more efficient because when the female leaps onto the back of a host to oviposit, the gaster is bent downwards and the ovipositor is inserted in the apical area of the abdomen. The petiole of *Townesilitus* is the only example among parasites of adult Coleoptera which has the ventral margins of tergite 1 fused with the sternite.

This structural modification may have developed to give greater strength to the gaster during the downward thrust of the ovipositor than it would have if the ventral margins of tergite 1 were separated from the sternite.

Much of the heterogeneity in the present tribe Euphorini results from a grouping of nymphal parasites with those of adult insects. This anomaly would be resolved, at least in part, by recognition of these apparently natural groups as representing different tribes. Accordingly, it is here proposed to erect a new tribe, the Perilitini (from the oldest genus Perilitus Nees 1818), to include those genera whose parasites attack adult insects and to restrict the parasites of nymphs to the tribe Euphorini. The Nearctic tribes of the Euphorinae and the genera of Euphorini and Perilitini are determined in the following keys.

## KEY TO NEARCTIC TRIBES OF THE EUPHORINAE

1. Tergite 1 sessile or subsessile with spiracles near base. Parasites of adult Scolytidae .................... Cosmophorini
   Tergite 1 petiolate or subpetiolate or long and slender with spiracles at or slightly behind middle .................... 2.
2. Tergite 1 with ventral margins free from sternite, strongly petiolate. Lateral margins of tergite 2 carinate. Second cubital cell closed and medius present and straight. Cocoon pensile. Parasites chiefly of larvae of Lepidoptera .................... Meteorini
   Tergite 1 with ventral margins free from or fused with sternite, subpetiolate or long and slender. Lateral margins of tergite 2 non-carinate. Second cubital cell, if present, open and medius present and bowed, or second cubital cell closed and medius affaced. Cocoon not pensile, in soil .................... 3.
3. Ovipositor subexserted or very short (sometimes extruded in death) with sheaths not longer than scape combined with pedicel. Petiole short or if unusually long then as long as gaster behind petiole. Front wing with strong medius and 3 cubital cells, or weak or effaced medius and 1- 2 cubital cells. First abscissa of cubitus usually present but if absent then ventral margins of tergite 1 not fused with sternite or gaster not strongly laterally compressed. Parasites of nymphs of Heteroptera and Psocoptera .................... Euphorini
   Ovipositor prominently exserted with sheaths greatly longer than scape combined with pedicel. Petiole usually short, but if unusually long and slender then not as long as gaster behind petiole. Front wing with weak or effaced medius and 2-3 cubital cells and first abscissa of cubitus present or absent, or strong medius and first abscissa of cubitus present or absent. Parasites of adult Coleoptera, Hymenoptera and Neuroptera or host unknown .................... Perilitini

## KEY TO NEARCTIC GENERA OF THE TRIBE EUPHORINI

1. Front wing with 3 cubital cells (Fig. 5). Parasites of Pentatomidae .................... Aridelus Marshall
   Front wing with 1 or, more usually, 2 cubital cells .................... 2.
2. Tergite 1 with ventral margins widely separated from base to apical margin, or ventral margins meeting only at base. Ovipositor subexserted and strongly decurved .................... 3.
   Tergite 1 with ventral margins fused with sternite, or apparently fused but with margins nearly touching or one margin overlapping the other. Ovipositor subexserted or very short and straight or weakly decurved .................... 4.
3. Ventral margins of tergite 1 widely separated from base to apex. Parameres of male genitalia extend basally on ventral side and longer than aedeagus. Front wing veins usually reduced and nervellus often incomplete or absent in hind wing (Fig. 6). Parasites of Miridae .................... Leiophron Nees
   Ventral margins of tergite 1 usually meeting at base and opening posteriorly. Parameres of male genitalia about as long on dorsal side as on ventral and not as long posteriorly as aedeagus. Apart from effaced medius, wing veins not reduced and nervellus always present (Fig. 7). Parasites of Miridae .................... Peristenus Foerster
4. Front wing with 2 cubital cells and complete radius. Nervellus present. Petiole long and slender, thickened medially. Ovipositor straight (Fig. 8). Parasites of Nabidae .................... Wesmaelia Foerster
   Front wing with 1 or 2 cubital cells and incomplete or effaced radius. Nervellus absent or weakly indicated at base. Petiole slender but not unusually long and not thickened medially. Ovipositor straight or weakly decurved. Smaller parasites .................... 5.
5. Ventral margins of tergite 1 apparently fused but margins slightly apart or one margin overlaps the other. Wing veins greatly reduced with only basal, submedius, cubitus, nurvulus basally present in front wing. Ovipositor barely perceptible, weakly decurved, (Fig. 9). Parasites of Psocidae .................... Euphoriella Ashmead
   Ventral margins of tergite 1 fused with sternite. Wing veins less reduced but second

abscissa of radius incomplete approaching wing margin. Ovipositor straight (Fig. 10). Parasites of Tingidae .................... Holdawayella Loan

### KEY TO NEARCTIC GENERA OF THE TRIBE PERILITINI

1. Medius weak basally or effaced. Parasites of Hymenoptera, Neuroptera or host unknown .................... 2.

Medius strong. Parasites of Coleoptera .................... 4.

2. Front wing with 3 cubital cells. First abscissa of cubitus and nervellus present. Petiole cylindrical, unusually long and slender, about as long as thorax and propodeum (Fig. 11). Parasites of Chrysopidae .................... Chrysopophthorus Goidanich

Front wing with 2 cubital cells. First abscissa of cubitus absent, nervellus present or absent. Petiole cylindrical or dorsoventrally compressed, shorter than thorax and propodeum .................... 3.

3. Gaster strongly laterally compressed. Eyes of female very large and prominent. Petiole dorsoventrally compressed, ventral margins of tergite 1 not fused with sternite, dorsal face with deep and long glymmae. Nervellus present (Fig. 12). Host unknown .................... Myiocephalus Marshall

Gaster not unusually laterally compressed. Eyes not unusually prominent. Petiole cylindrical with ventral margins of tergite 1 fused with sternite, dorsal face without glymmae. Nervellus absent (Fig. 13). Parasites of Bombidae, Ichneumonidae .................... Syntretus Marshall

4. Flagellum short with 8- 12 articles, unmodified or proximal and distal articles elongated and scape short .................... 5.

Flagellum not unusually short with at least 15 articles, unmodified or geniculate with basal articles specialized or simple. Scape elongated or short .................... 6.

5. Flagellum clavate with proximal and distal articles elongated. Wing veins relatively complete (Fig. 14). Parasites of Scolytidae .................... Ropalophorus Haliday

Flagellum non- clavate. Wing veins reduced with recurrent, subcostella, submediella, and nervellus absent (Fig. 15). Parasites of Scolytidae .................... Cryptoxilos Viereck

6. Flagellum geniculate. Scape elongated and basal flagellar articles specialized by structure and pubescence, or non- specialized. Wing veins complete except first abscissa of cubitus absent (Fig. 16). Parasites of Chrysomelidae .................... Streblocera Westwood

Flagellum nongeniculate. Scape short and basal flagellar articles unmodified .................... 7.

7. First abscissa of cubitus present (Fig. 17). Parasites of Coccinellidae, Curculionidae, Morabinae (Orthoptera) .................... Perilitus Nees

First abscissa of cubitus absent .................... 8.

8. Clypeus longer than wide and strongly convex. Tergite 1 with ventral margins widely separated between base and apical margin. Female oviposits from the substrate without leaping onto back of host (Fig. 18). Parasites chiefly of Chrysomelidae and Curculionidae .................... Microctonus Wesmael

Clypeus unusually wide, at least 2.0 times as wide as long and almost flat. Petiole cylindrical in front of spiracles with ventral margins of tergite 1 fused with sternite. Female leaps onto back of host to oviposit (Fig. 19). Parasites of Chrysomelidae .................... Townesilitus Haeselbarth and Loan

Muesebeck (1963) briefly outlined the host relations of the Nearctic genera of euphorines, demonstrating that each genus attacks a specific host group. Perilitus Nees, however, is a unique exception as it not only attacks weevils and leaf beetles in Europe (Jackson 1928, Loan and Holdaway 1961, Waloff 1961) but it is also a parasite of morabine grasshoppers in Australia (Blakith 1967). Hosts are known for 10 of the Nearctic genera and inferred for 3 others from Palearctic records (Aridelus Marshall, Capek and Davidova-Vilimova 1978; Perilitus loc cit; Syntretus Foerster, Cole 1959, Alford 1968) and 1 from the Orient (Streblocera Westwood, Watananbe 1942). The host of Myiocephalus Marshall is unknown. The associations are listed in Table 1 with the stage attacked and the stage killed. The tribe Euphorini, in the restricted sense proposed in this paper, has almost as many genera and nearly twice as many species as the tribe Perilitini.

The known parasite life cycles are closely integrated with their host life histories and modifications are found more in the genera attacking nymphs than in the parasites of Coleoptera. Parasites (Euphoriella, Leiophron, Peristenus) whose hosts (psocids, plant bugs) overwinter as eggs pass the winter as diapausing adults in larval cocoons and emerge to attack early instar nymphs (Fig. 1) (psocid parasites Sommerman 1956; plant bug parasites Waloff 1967, Loan 1980). The parasite cocoons overwinter in soil, but I have also found Euphoriella cocoons beneath tree bark. Other parasites overwinter as first instar larvae in adult hosts though Chrysopophthorus is exceptional because it overwinters in the larval cocoon, stage unknown (Raymond Manuel *in litt*). The tingid parasite *Holdawayella* attacks fifth instar nymphs that are mature by mid-summer and synchronizes with them by slow development of the overwintered larva and of the cocoon stages (Fig. 2) (Loan, Gerber and Reid, 1971). *Microctonus colesi* Drea, a parasite of the alfalfa weevil *Hypera postica* Gyll., shows a remarkably similar adaptation to its host. This, the only known species of *Microctonus* to exclusively parasitize larvae attacks late instar hosts and the first instar parasite larva diapauses in the adult host and over winters; thus its life cycle corresponds closely with that of *Holdawayella* (Fig. 2). *Wesmaelia* has 2 broods of parasites in the season which attack fifth instar nymphs in early and late summer (Fig. 3). At Ottawa, I have reared larvae of *Wesmaelia* as early as April, and recovered eggs laid by the second brood of parasites as late as September. The genus *Aridelus* has only been reared in the Palearctic region. Capek and Davidova-Vilimova (1978) identified larvae of *A. egregius* (Schmiedeknecht) from early and late instar nymphs of the pentatomid *Captosoma*. They suggest that the first instar larva overwinters; the oviposition behavior of *A. egregius* was not observed.

Life-histories of 3 of the genera attacking adult Coleoptera, *Microctonus*, *Perilitus* and *Townesilitus* are well known (*Microctonus*, Nearctic records in Loan 1969; *Perilitus*, Balduf 1926; *Townesilitus*, as *Microctonus psylliodis* Loan, *M. cucumeridis* Loan, *M. crepidoderae* Loan, *loc cit*). The life cycles of these parasites (Fig. 4) and that of the *Nabis* parasite *Wesmaelia* closely agree with the chief difference that the first brood of parasites of the former attack overwintered, sexually active hosts. Of the euphorines parasitic on other adult insects, *Syntretus* has not as yet been reared from a Nearctic host but, in Europe, species are recorded from ichneumonids (Cole 1959) and bumble-bees (Alford 1968). In New Jersey in September 1970, numerous *Syntretus*, presumably searching for hosts, were captured in black light traps (James Stewart *in litt*). Thus the species may overwinter in adult hosts as first instar larvae. The life cycle of *Chrysopophthorus* appears similar to that of *Microctonus* with 2 broods of the parasite attacking the bivoltine host (Raymond Manuel *in litt*).

## Acknowledgements

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5 - 19. Wings. 5, *Aridelus*; 6, *Leiophron*; 7, *Peristenus*; 8, *Wesmaelia*; 9, *Euphoriella*; 10, *Holdawayella*; 11, *Chrysopophthorus*; 12, *Myiocephalus*; 13, *Syntretus*; 14, *Ropalophorus*; 15, *Cryptoxilos*; 16, *Streblocera*; 17, *Perilitus*; 18, *Microctonus*; 19, *Townesilitus*.

Note: Figures 5 - 19 are not to scale and are diagrammatic in area and outline.

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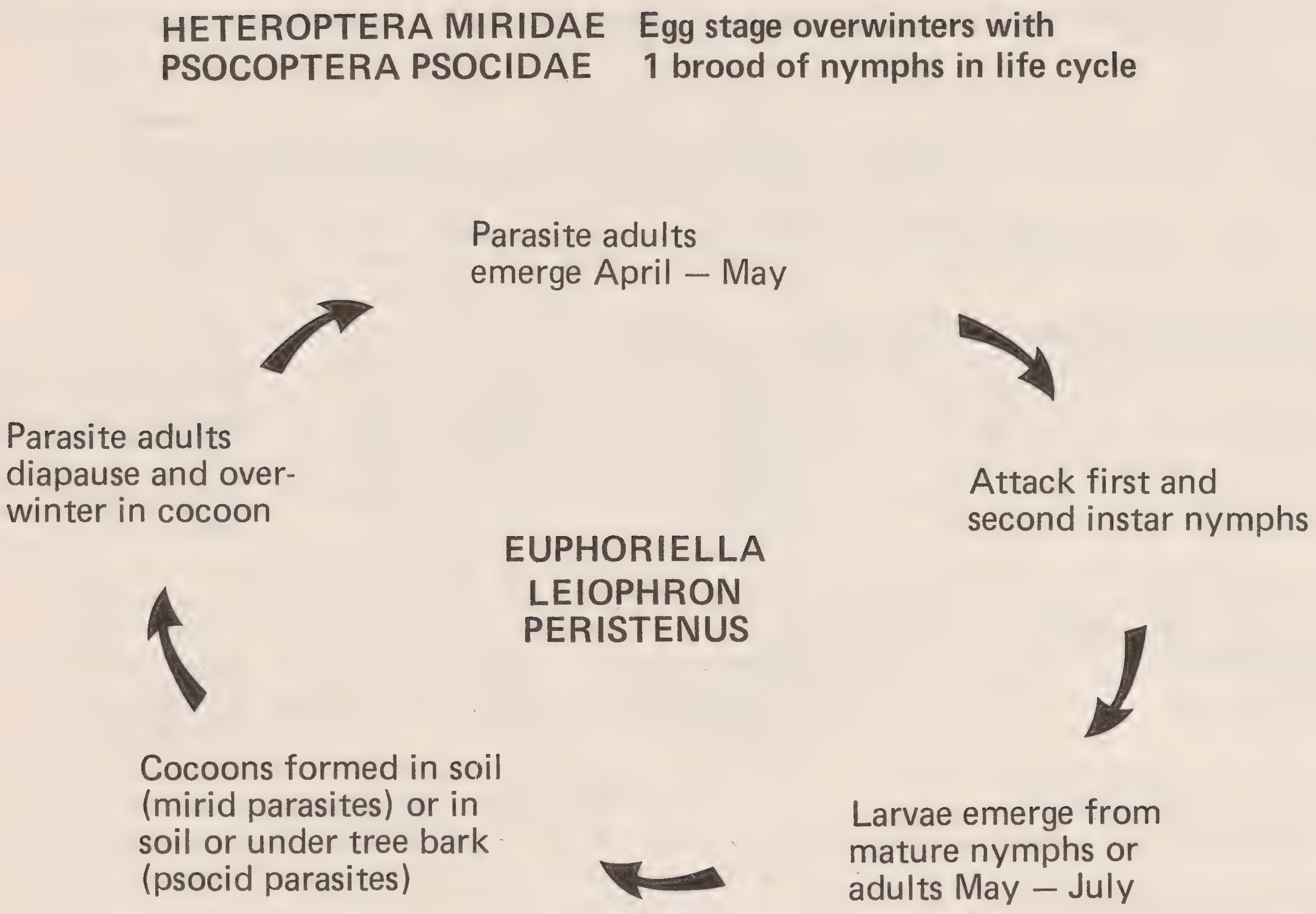
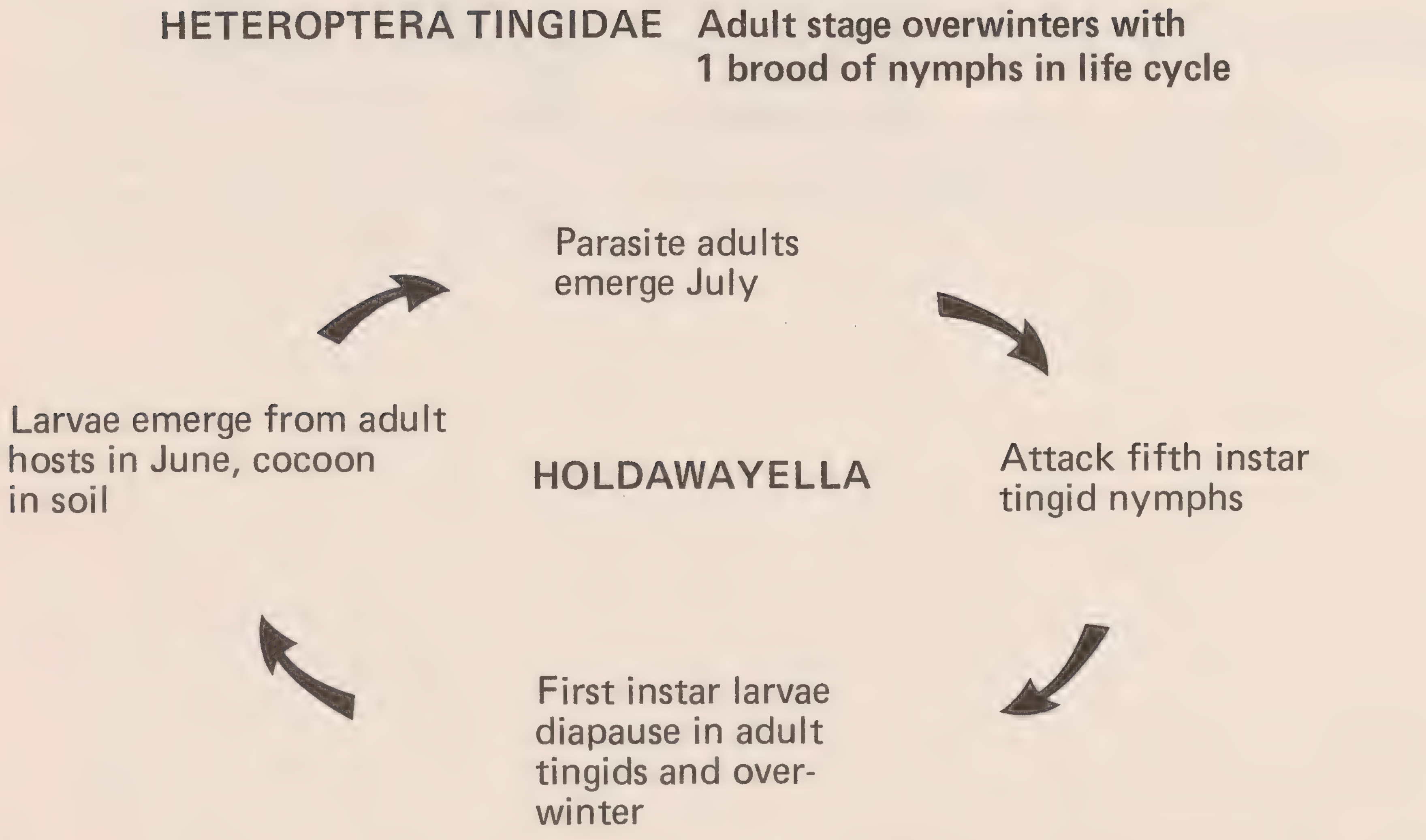
Table 1. Hosts of Nearctic euphorine and perilitine genera with stage attacked and stage killed

| Parasite Genus | Number Nearctic Species | Family of Host | Stage of host | |
|---|---|---|---|---|
| | | | Attacked | Killed |
| EUPHORINI | | | | |
| Parasites of Heteroptera and Psocoptera | | | | |
| Aridelus | 3 | Pentatomidae | Early nymph | Nymph and adult |
| Leiophron | 19 | Miridae | Early nymp | Nymph and adult |
| Peristenus | 25 | Miridae | Early nymph | Nymph and adult |
| Wesmaelia | 1 | Nabidae | Late nymph | Adult |
| Euphoriella | 10 | Psocidae | Early nymph | Nymph and adult |
| Holdawayella | 2 | Tingidae | Late nymph | Adult |
| PERILITINI | | | | |
| Parasites of Hymenoptera and Neuroptera | | | | |
| Chrysopophthorus | 1 | Chrysopidae | Adult | Adult |
| Syntretus | 3 | Ichneumonidae | Adult | Adult |
| | | Bombidae | Adult | Adult |
| Parasites - host - unknown | | | | |
| Myiocephalus | 1 | | | |
| Parasites of Coleoptera | | | | |
| Ropalophorus | 1 | Scolytidae | Adult | Adult |
| Streblocera | 1 | Chrysomelidae | Adult | Adult |
| Cryptoxilos | 1 | Scolytidae | Adult | Adult |
| Perilitus | 2 | Coccinellidae | Adult | Adult |
| | | Curculionidae | | |
| Townesilitus | 3 | Chrysomelidae | Adult | Adult |
| Microctonus | 25 | Carabidae | Adult | Adult |
| | | Chrysomelidae | Adult/larva | Adult |
| | | Curculionidae | Adult/larva | Adult |
| | | Nitidulidae | Adult | Adult |
| | | Tenebrionidae | Adult | Adult |

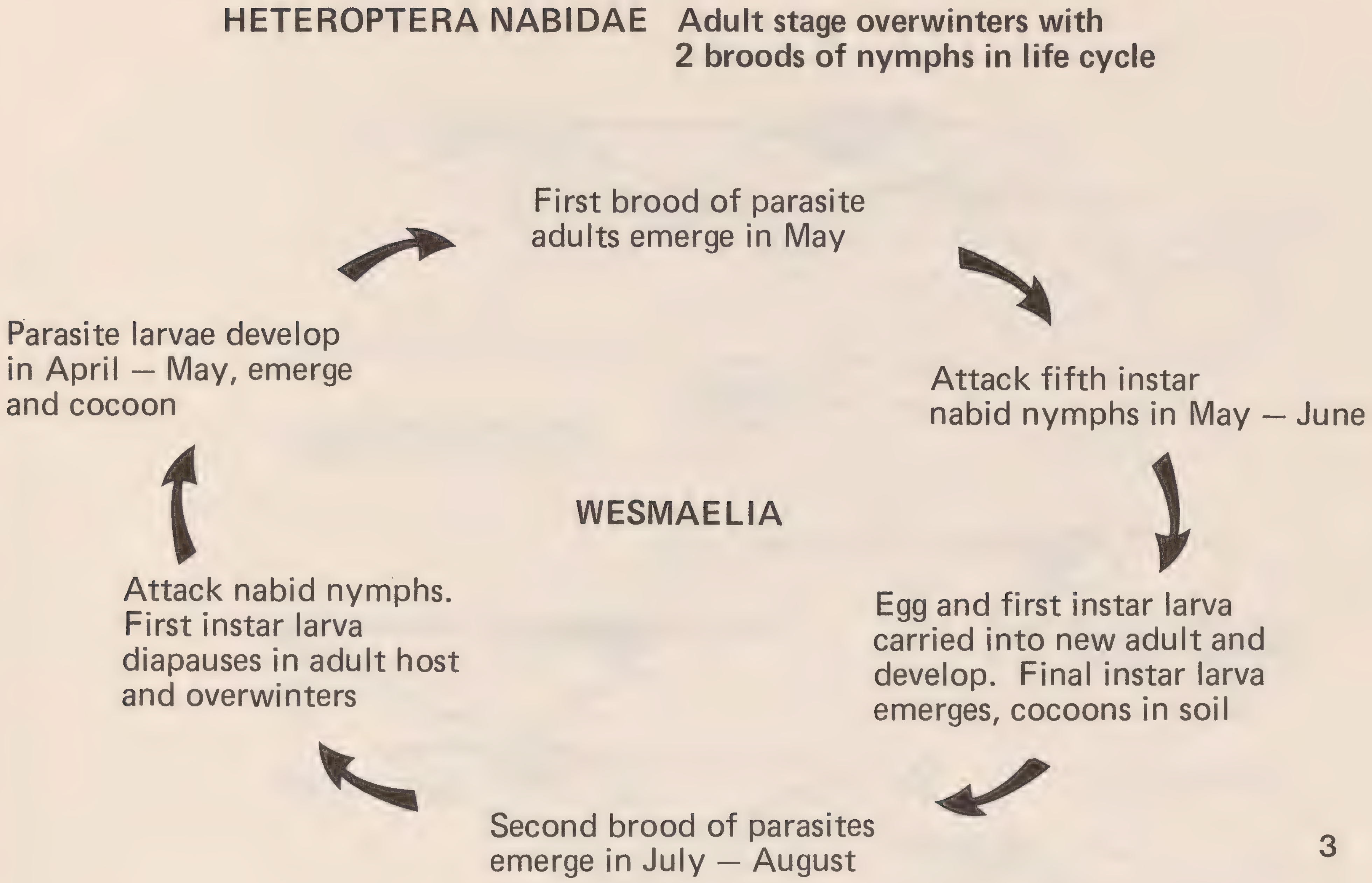

HETEROPTERA MIRIDAE
PSOCOPTERA PSOCIDAE
Egg stage overwinters with 1 brood of nymphs in life cycle
Parasite adults emerge April — May
Attack first and second instar nymphs
Larvae emerge from mature nymphs or adults May — July
Cocoons formed in soil (mirid parasites) or in soil or under tree bark (psocid parasites)
Parasite adults diapause and overwinter in cocoon
EUPHORIELLA
LEIOPHRON
PERISTENUS

1

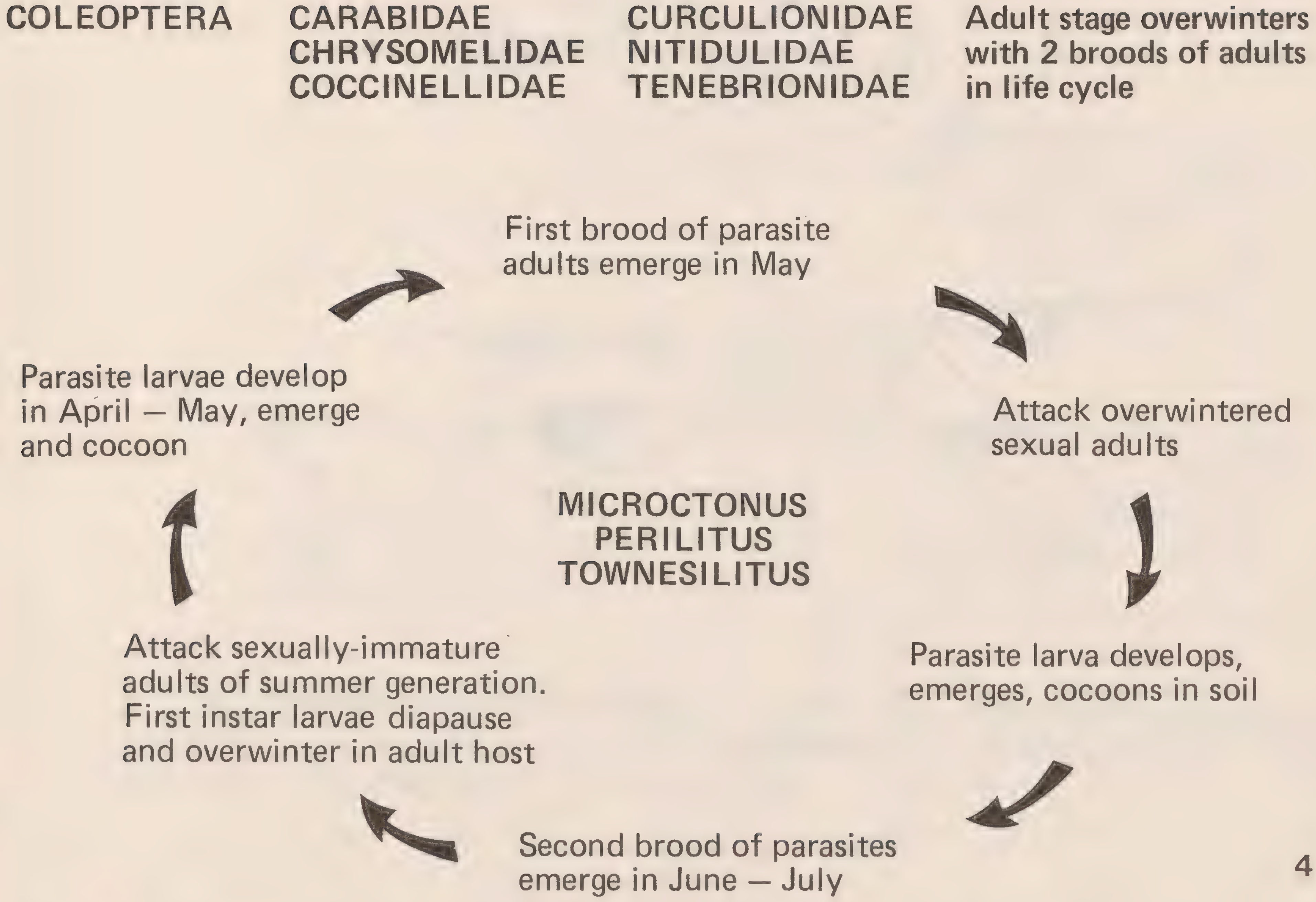

HETEROPTERA TINGIDAE
Adult stage overwinters with 1 brood of nymphs in life cycle
Parasite adults emerge July
Attack fifth instar tingid nymphs
First instar larvae diapause in adult tingids and overwinter
Larvae emerge from adult hosts in June, cocoon in soil
HOLDAWAYELLA

2

Figs. 1–2. Life cycle outlines: 1, **Euphoriella, Leiophron, Peristenus.** 2, **Holdawayella.**

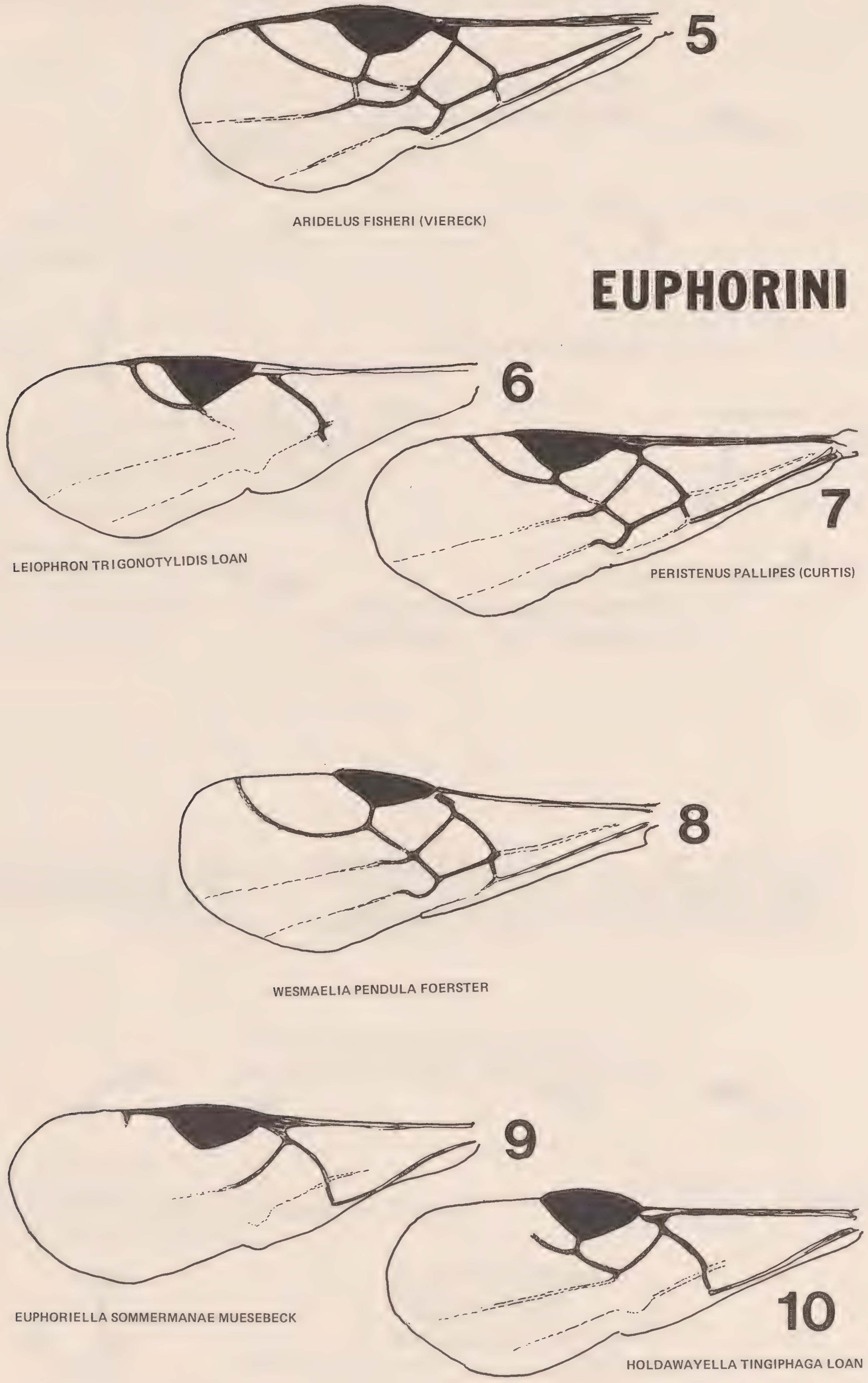

HETEROPTERA NABIDAE
Adult stage overwinters with 2 broods of nymphs in life cycle
First brood of parasite adults emerge in May
Attack fifth instar nabid nymphs in May — June
Egg and first instar larva carried into new adult and develop. Final instar larva emerges, cocoons in soil
Second brood of parasites emerge in July — August
Attack nabid nymphs. First instar larva diapauses in adult host and overwinters
Parasite larvae develop in April — May, emerge and cocoon
WESMAELIA

3

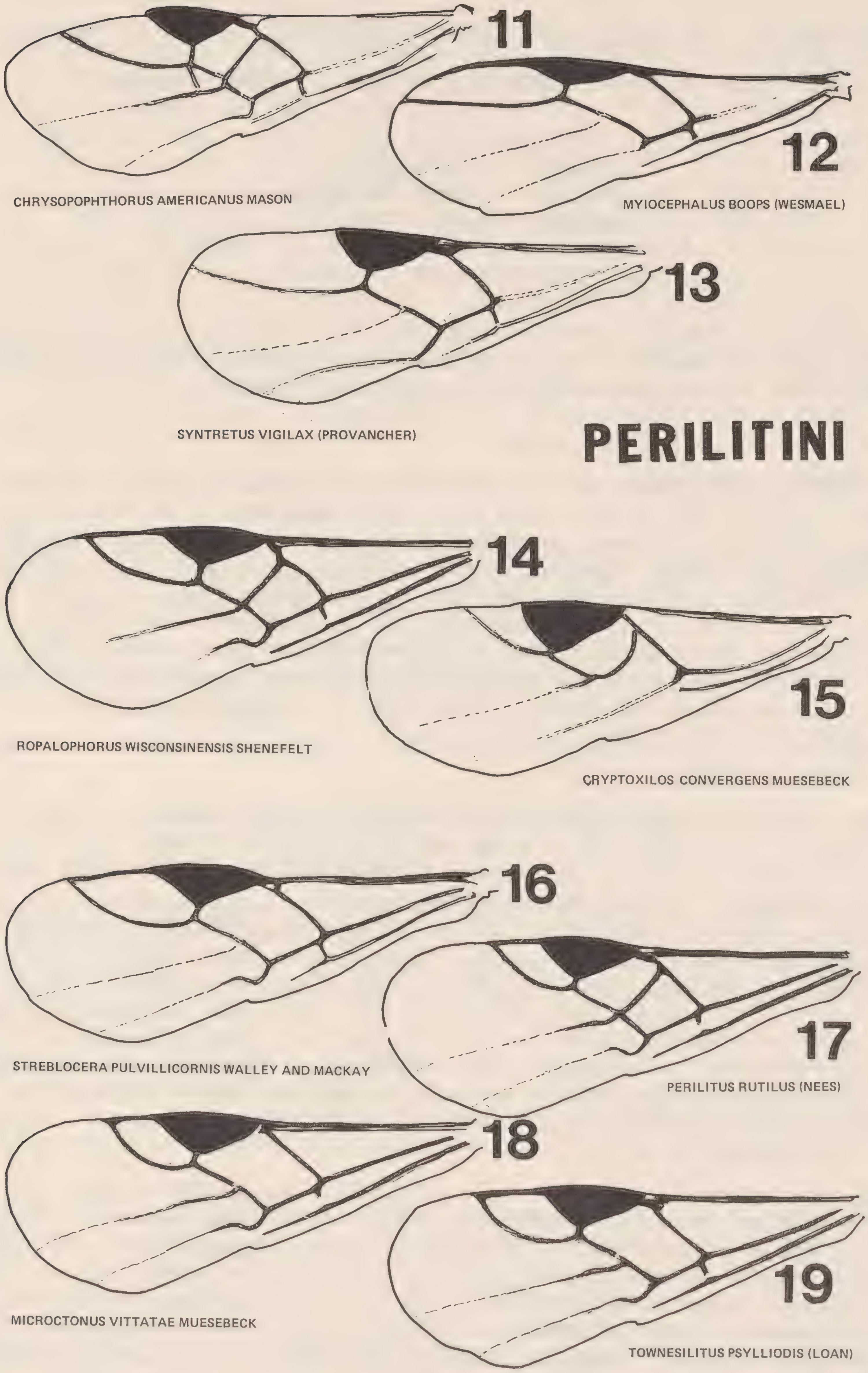

COLEOPTERA
CARABIDAE
CHRYSOMELIDAE
COCCINELLIDAE
CURCULIONIDAE
NITIDULIDAE
TENEBRIONIDAE
Adult stage overwinters with 2 broods of adults in life cycle
First brood of parasite adults emerge in May
Attack overwintered sexual adults
Parasite larva develops, emerges, cocoons in soil
Second brood of parasites emerge in June — July
Attack sexually-immature adults of summer generation. First instar larvae diapause and overwinter in adult host
Parasite larvae develop in April — May, emerge and cocoon
MICROCTONUS
PERILITUS
TOWNESILITUS

4

Figs. 3-4. Life cycle outlines: 3, **Wesmaelia**. 4, **Microctonus, Perilitus, Townesilitus.**


5
ARIDELUS FISHERI (VIERECK)
EUPHORINI
6
LEIOPHRON TRIGONOTYLIDIS LOAN
7
PERISTENUS PALLIPES (CURTIS)
8
WESMAELIA PENDULA FOERSTER
9
EUPHORIELLA SOMMERMANAE MUESEBECK
10
HOLDAWAYELLA TINGIPHAGA LOAN

Figs. 5-10. Wings: 5, **Aridelus.** 6, **Leipphron.** 7, **Peristenus.** 8, **Wesmaelia.** 9, **Euphoriella.** 10, **Holdawayella.**


11
12
CHRYSOPOPHTHORUS AMERICANUS MASON
MYIOCEPHALUS BOOPS (WESMAEL)
13
SYNTRETUS VIGILAX (PROVANCHER)
PERILITINI
14
15
ROPALOPHORUS WISCONSINENSIS SHENEFELT
CRYPTOXILOS CONVERGENS MUESEBECK
16
17
STREBLOCERA PULVILLICORNIS WALLEY AND MACKAY
PERILITUS RUTILUS (NEES)
18
19
MICROCTONUS VITTATAE MUESEBECK
TOWNESILITUS PSYLLIODIS (LOAN)

Figs. 11-19. Wings: 11, **Chrysopophthorus.** 12, **Myiocephalus.** 13, **Syntretus.** 14, **Ropalophorus.** 15, **Cryptoxilos.** 16, **Streblocera.** 17, **Perilitus.** 18, **Microctonus.** 19, **Townesilitus.**